AMENDMENTS TO THE SPECIFICATION:

Please amend the paragraphs beginning at page 1, lines 6, as follows:

TECHNICAL FIELD ~~OF THE INVENTION~~

The ~~present invention~~ technical field of the disclosure relates to arrangements and a method in a third generation mobile telecommunication system and evolved variants thereof. In particular, the ~~invention~~ technical field relates to arrangements and a method for handling macro diversity in a UMTS Radio Access Network (UTRAN).

BACKGROUND ~~OF THE INVENTION~~

Please amend the paragraphs beginning at page 2, line 9, as follows:

FIG. 1 illustrates a UTRAN. The Radio Network Controller (RNC) 102 is connected to the Core Network 100 that in turn may be connected to another network. The RNC 102 is connected to one or more Node Bs 104 also denoted base stations via a transport network 106. The transport network 106 may e.g. be IP-based or ATM-based. The transport network nodes 108 are indicated with a "T" in FIG. 1. In an IP based transport network these nodes are IP routers. In an ATM based transport network the transport network nodes are AAL2 (ATM Adaptation Layer type 2) switches. The Node Bs 104 may be wirelessly connected to one or several User Equipments (UEs) 110 also denoted mobile terminals. A Serving-RNC (S-RNC) 102 is a RNC that has a Radio Resource Connection (RRC) connection with the UE 110. A Drift-RNC (D-RNC) 112 is a

RNC that may be connected to a UE 110, but where another RNC 102, i.e. the S-RNC, handles the RRC connection with the UE 110.

Macro diversity enables a mobile station to communicate with a fixed network by more than one radio link, i.e. a mobile terminal can send/receive information towards/from more than one radio port (or base station also denoted Node B). The radio ports (RPs) are spatially separated at distance from a short distance, e.g. between different floors in a building, (pico-cells) up to about some kilometres (micro- and macro-cells). As the propagation conditions between the mobile terminal and the different RPs, are different at the same moment in time, the resulting quality of the combination of the received signals is often better than the quality of each individual signal. Thus, macro diversity can improve radio link quality. When a mobile terminal is connected to more than one base station simultaneously, the UE is said to be in soft handover.

Please amend the paragraphs beginning at page 5, line 8 through page 6, line 4, as follows:

SUMMARY ~~OF THE INVENTION~~

The consumed transmission resources are reduced ~~according to~~ in one or more embodiments of the present invention by distributing the macro diversity functionality to the Node Bs. A problem is then how to select which of the connected Node Bs that should be selected to perform the combining/splitting function, also referred to as a Diversity Handover (DHO) function. These selected nodes are referred to as DHO nodes. The DHO nodes ~~have to be~~ are

selected out of those Node Bs that are able to perform the DHO functionality, i.e. out of those Node Bs that have been adapted with DHO functionality~~and other functions of the present invention~~. These nodes are referred to as DHO enabled nodes or macro diversity enabled nodes.

~~The object of the present invention is to solve the above stated problem.~~

~~The problem is solved by the arrangements according to claims 25, 26 and 27 and the method of claim 1.~~

~~The most important~~ An advantage achieved ~~by the present invention~~ is transmission savings in the UTRAN transport network, which translate into significant cost savings for the operator. The transmission savings are realised through optimised location the DHO functionality. Thereby the redundant data transport is eliminated in the parts of the path, where data pertaining to different macro diversity legs of the same DCH would otherwise be transported in parallel along the same route.

Another advantage ~~of the present invention~~ is that ~~it facilitates that~~ RNCs may be located in more central locations of the network (i.e. with less geographical distribution). ~~The main purpose~~ A goal of the current common geographical distribution of RNCs is to limit the transmission costs for the parallel macro diversity legs. When this parallel data transport is eliminated, it becomes more beneficial for an operator to centralise the RNCs, e.g. by co-locating them with MSCs or MGWs. Co-locating several nodes on the same site results in simplified operation and maintenance, which also means reduced costs for the operator.

Please amend the paragraphs beginning at page 6, line 19, as follows:

FIG. 4 illustrates the potential transmission savings in an example with cascaded Node Bs~~ according to the present invention~~.

FIG. 5 illustrates a scenario with a mobile terminal using five macro diversity legs~~ according to the present invention~~.

Please amend the paragraph beginning at page 7, line 1, as follows:

FIG. 10 shows the modified DHO node tree after the first step of the delay reduction method number 5 according to an embodiment~~ of the invention~~.

Please amend the paragraph beginning at page 7, line 5, as follows:

FIG. 12 shows the modified DHO node tree after the second step of the delay reduction method number 5 according to an embodiment~~ of the invention~~.

Please amend the paragraph beginning at page 7, line 13, as follows:

FIG. 16 shows the modified DHO node tree after the first step of the delay reduction method number 6 according to an embodiment~~ of the invention~~.

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Please amend the paragraph beginning at page 7, line 17, as follows:

FIG. 18 is a flowchart of ~~one of the methods according to the present invention~~ an example method.

Please amend the paragraphs beginning at page 8, line 1 through page 9, line 28, as follows:

In the further description ~~of the present invention~~ coordinated DCHs are not specifically treated. In the aspects that are significant ~~to the present invention~~ a set of coordinated DCHs is treated in the same way as a single separate DCH. The DCHs of a set of coordinated DCHs use a common transport bearer and in an IP UTRAN the frames (of a set of coordinated DCHs) with the same CFN are included in the same User Datagram Protocol (UDP) packet. The special combining procedure for coordinated DCHs has been described above. Thus, omitting coordinated DCHs serves to simplify the description ~~of the present invention~~ and makes the text more readable. ~~To generalize the description of the present invention so as to comprise coordinated DCHs would be conceptually trivial for a person of ordinary skills in the art, although it would significantly complicate the text~~.

The ~~present invention~~ embodiment(s) may be implemented in a third generation mobile telecommunications system, e.g. in a UMTS, and in particular in the Radio Access Network (RAN), e.g. a UMTS Terrestrial Radio Access Network, UTRAN. Such a system is illustrated in FIG. 1 and described above in conjunction with FIG. 1.

In order to reduce the required transmission resources, ~~the present invention proposes~~ it is proposed to distribute the macro diversity functionality from the RNC to other nodes for macro diversity configurations for which this is beneficial from a transmission point of view. These other nodes are typically Node Bs, but may also be other types of nodes, e.g. specialized Diversity Handover nodes. The potential transmission savings when the macro diversity is distributed to Node Bs are illustrated in FIG. 4. When a macro diversity configuration is established, or changed, ~~it is first required to select~~ the Node Bs that should be the Diversity Handover (DHO) nodes are first selected, i.e. the Node Bs that should perform the actual combining and splitting, before the macro diversity function is executed. The DHO nodes ~~have to~~ should be selected out of the available nodes that ~~comprise~~ include DHO functionality, i.e. out of the DHO enabled nodes (typically DHO enabled Node Bs). In the examples below, the Node Bs and the RNC are used as DHO nodes, but it should be noted that other nodes such as specialized DHO nodes or logically or geographically distributed RNCs or future types of nodes implementing parts of the RNC functionality also may be used as DHO nodes. In order to select the DHO nodes, the first step that is performed is to obtain topology information of the UTRAN transport network and how the nodes within the transport network are connected to the Node Bs. The topology information may for example be obtained in the topology map illustrated in FIG. 5.

The topology information ~~is according to the present invention~~ can be obtained by developing a topology database. The topology database is adapted

to provide the RNC with the information the RNC needs in order to determine when distribution of the DHO functionality to the Node Bs is beneficial and to select the Node Bs to be involved. The topology database is first described for an Internet Protocol (IP) based UTRAN, including its general properties and ways to create it. Then, in a further section, the topology database for an ATM based UTRAN is described.

The selection of the DHO node(s) ~~requires~~ implies that the RNC comprises or is adapted to retrieve information about the topology of the UTRAN, both the UTRAN transport network and the Node Bs and RNCs. Different levels of richness of this information are conceivable. The choice of this level is a trade-off between the value it provides for the DHO node selection mechanism and the complexity it implies for the selection mechanism as well as the topology information retrieval mechanism. A certain level of flexibility of the richness of the topology information will be allowed in the further description of the DHO node selection.

However, the topology information with a basic level of richness ~~comprises according to the present invention~~ should include:

A hop-by-hop route from the RNC to each Node B that is controlled by the RNC and possibly some Node Bs that are controlled by neighboring RNCs, wherein each router is represented by the IP address associated with the interface that is used to forward packets in the direction of the RNC. The Node B is represented by one of its IP addresses, e.g. the one used for NBAP (Node B Application Part) signaling (or the primary IP address used for NBAP signaling

in case multiple IP addresses are used for NBAP signaling). If a neighboring RNC is included in a hop-by-hop route, it is also represented by one of its IP addresses, e.g. the one used for RNSAP (Radio Network Subsystem Application Part) signaling (or the primary IP address used for RNSAP signaling in case multiple IP addresses are used for RNSAP signaling).

Please amend the paragraphs beginning at page 11, line 9, as follows:

In addition to the ~~required~~ topology information the RNC ~~must~~ should be manually or automatically configured with knowledge about the relevant Node Bs that are able to comprise DHO functionality, also referred to as DHO enabled nodes. The DHO enabled nodes are at least constituted by the DHO enabled nodes controlled by the RNC, but in inter-RNS macro diversity configurations they may also include other RNCs and Node Bs controlled by other RNCs. It is also possible that the DHO enabled nodes may include other, yet non-existing, types of Radio Network Layer (RNL) nodes, e.g. specialized DHO nodes. The RNC ~~is required to~~ should know one IP address of each DHO enabled node, preferably the IP address used for NBAP signaling (or RNSAP signaling in the case of an RNC). This IP address ~~is required to~~ should be the same IP address as is used to represent the node in a hop-by-hop route. The RNC may be adapted to use the list of DHO enabled nodes to include an indication of whether the node is DHO enabled or not for each node in the hop-by-hop routes.

~~According to embodiments of the present invention, there are~~ There can be four possible ways for an RNC to provision the required topology information:

1. Through manual or semi-automatic management operations. When the UTRAN (including its transport network) is built or changed, the relevant topology information is configured in the RNC via O&M means.

2. Via a link state routing protocol. If a link state routing protocol, e.g. Open Shortest Path First (OSPF), is used in the UTRAN transport network, the RNC may be adapted to participate in the routing protocol communication as if it were a router. However, assuming that the RNC does not have a router function (i.e. the IP forwarding function) it would not announce reachability to any network other ~~network~~ than the site infrastructure LAN. Therefore, in practice, no node ~~would ever~~ is likely to attempt to use the RNC as a transit node, a node that forwards traffic, i.e. a node that is neither the source node nor the destination node. Thus, through the routing protocol the RNC ~~comprises~~ can include means for maintaining an up-to-date topology database, without being required to perform other router functions.

Please amend the paragraphs beginning at page 12, line 12, as follows:

4. By retrieving topology information from another RNC. However, this method is ~~only feasible~~ more applicable in the inter-RNs case.

The third of the above listed ways to provision topology information, i.e. the traceroute mechanism, ~~requires a~~ is further ~~detailed description~~ described.

Since the destination nodes, i.e. the Node Bs, are not arbitrary nodes in the network, they may be prepared for the traceroute messages. This allows the traceroute program to work slightly differently from traditional traceroute programs (although a traditional traceroute program would work too). A future IP based UTRAN will ~~assumedly~~ presumably use IPv6, but for completeness an RNC traceroute program variant for IPv4 is also described.

Please amend the paragraph beginning at page 15, line 6, as follows:

When IPv4 is used the Time Exceeded ICMPv4 Message and the Destination Unreachable ICMPv4 Message do not have to comprise more than 28 octets of the invoking packet. That is, there ~~is~~ may be room only for the IP header and the UDP header of the message from the RNC, which means that there is no point to include information in the UDP payload (unless the information is intended for the target Node B). The RNC traceroute program then has to work as traditional traceroute programs. That is, for each of its sequentially sent messages, it increases the destination UDP port number by one. The RNC is also required to store the destination address, the destination port, the hop limit and the time of sending for each message that it sends.

Please amend the paragraphs beginning at page 16, line 14, as follows:

To improve the stability of the traceroute delay measurements, the traceroute messages could be sent on high priority bearers, but the response messages from the Node B ~~should~~ is preferred to be sent on the same type of

bearer as the ICMP messages in order to provide a delay measurement (for the last hop) that can be compared with the delay measurements for the other hops. However, whether high priority bearers are used or not several traceroute measurements ~~should~~ can be averaged in order to provide high quality delay measurements. The RNC could calculate the averages by repeating complete sets of traceroute messages or by repeating each traceroute message in a set.

Running a number (e.g. 3-5) of traceroute measurements (i.e. sets of traceroute messages) towards each base station in the RNS periodically such as every 24 hours would enable the RNC to maintain a reasonably up-to-date topology database with reasonably accurate link delay metrics, while incurring an insignificant load in the transport network. The traceroute measurements ~~should~~ is preferred to be spread out during a period of low traffic load, e.g. during night-time.

Please amend the paragraphs beginning at page 19, line 22 through page 20, line 4, as follows:

The mechanism that the RNC is adapted to use in order to select the DHO node(s), i.e. the node(s) where the splitting and combining will be performed, is(are) the same whether optimized NBAP and RNSAP signaling is used or not. ~~The~~ An object of the DHO node selection mechanism ~~according to the present invention~~ is to select the DHO nodes in a way that minimizes one or more accumulated metric for the all the macro diversity legs. According to one embodiment of the present invention, such an accumulated metric is a

generic cost metric. According to a further embodiment this cost metric is put together with the condition that for none of the resulting data paths is the resulting path delay allowed to exceed a maximum delay value defined for the UTRAN.

In the typical scenario, a DCH is first established with a single leg, i.e. without macro diversity. When a second macro diversity leg is added, the RNC selects a DHO node for these two legs and redirects the existing data flow if necessary (i.e. unless the selected DHO node is the Node B of the first leg or the RNC itself. When a third leg is added, the RNC ~~is required to~~ can rerun the DHO node selection process from scratch, since the addition of the third leg may affect the selection of the first DHO node. The RNC also has the choice to let the third leg go all the way to the RNC (without trying to find a better DHO node) in order to not to affect the previous DHO node choice and to avoid the signaling involved in redirecting the existing flows. The same (i.e. rerunning the DHO node selection process from scratch or terminating the new leg in the RNC) applies to subsequently added macro diversity legs.

Please amend the paragraph beginning at page 23, line 9, as follows:

A retrieved hop-by-hop route is represented by a list of IP addresses (the IP addresses of the intermediate routers and the destination Node B), accompanied by a number of metrics for each hop. The IP address of the RNC ~~is~~ can be omitted, since it is not needed for the DHO node selection process. The metrics may include one or both of a delay metric and a generic cost metric

(based on arbitrary criteria). The metrics may be asymmetric, in which case one set of metrics is supplied for each direction of a link, or symmetric, in which case the same set of metrics is valid for both directions. In the illustrated example the metrics include both a symmetric delay metric and a symmetric generic cost metric according to one embodiment of the present invention. Table 1 shows the information that could be included in the route information that the RNC retrieves in the example scenario (i.e. the scenario depicted in FIG. 5).

Please amend the paragraph beginning at page 28, line 8, as follows:

The algorithm used for selecting a DHO node corresponding to a certain branching node is simple. Starting from the branching node the RNC is able to accumulate the generic cost metric in each direction (i.e. in the direction of each branch in the original route tree including the uplink) from the branching node until a DHO enabled node (or the end of the path) is found. (If asymmetric generic cost metrics are used, the generic cost metrics ~~has to~~ should be the accumulated roundtrip from the branching node to the found DHO enable node and back. If symmetric cost metrics are used it suffices to accumulate the generic cost metrics in one direction.) The RNC does this by using the original route tree--not the simplified one. The DHO enabled node that was found with the smallest accumulated generic cost metric is selected as the DHO node corresponding to the concerned branching node. If the branching node is itself

a DHO enabled node, it will of course be the selected DHO node, since it is obviously the best choice and the accumulated generic cost metric will be zero.

Please amend the paragraph beginning at page 29, line 15, as follows:

Returning now to the DHO node selection example based on the example scenario in FIG. 5, the DHO nodes corresponding to the identified branching nodes will be selected as follows. Since symmetric generic cost metrics are used in this example, the cost metric is accumulated in only a single direction between a branching node and a potential DHO node. The DHO node corresponding to branching node R7 is NB4, for which the accumulated generic cost metrics from R7 is 4. All the other DHO enabled nodes in the route tree have greater accumulated generic cost metrics from this branching node. Similarly, the selected DHO node corresponding to the branching node R5 is NB3, for which the accumulated generic cost metrics from R5 is 4. The selected DHO node corresponding to the branching node R4 is NB3 again, for which the accumulated generic cost metrics from R5 is 7. The selected DHO node corresponding to the branching node R2 is NB1, for which the accumulated generic cost metrics from R2 is ~~4~~ 1.

Please amend the paragraph beginning at page 32, line 14, as follows:

When the DHO nodes are selected, the last step before instructing the UTRAN nodes to establish the route tree including the selected DHO nodes is to check that the maximum allowed transport delay between a Node B and the

RNC is not exceeded. To do this, the connections in the DHO node tree are mapped onto the original route tree to form complete hop-by-hop routes. FIG. 9 illustrates this for the DHO node selection example based on the example scenario in FIG. 5, i.e. the DHO node tree of FIG. ~~8is~~ 8 is mapped on the route tree of FIG. 6. The resulting data flows are shown with the thicker arrows in FIG. 9.

Please amend the paragraphs beginning at page 36, line 1, as follows:

If either $D_{new\text{-}path\text{-}DL}$ or $D_{new\text{-}path\text{-}UL}$ exceeds the maximum allowed delay in the transport network (or a slightly lower delay threshold to provide a safety margin), the concerned path ~~must~~ should be changed. There are different ways to do this with different levels of complexity (and performance). Ideally the DHO node selection should be restarted with new conditions to arrive at a new result, possibly with entirely or partly new DHO nodes. The goal should be to achieve data paths with acceptable delays with as small increase as possible in the overall accumulated cost metrics compared to the first DHO node tree. However, another important goal is to keep the algorithm simple and computation efficient. Therefore the DHO node selection is preferably not restarted. Instead the concerned data path is modified in order to decrease its delay down to an acceptable level.

~~The~~ One way to modify the data path is to remove one or more DHO nodes from the path, until the path delay is smaller than the maximum allowed value. By removal of a DHO node from a path is meant that the concerned data

flow bypasses the DHO node. The removed DHO node may remain in the path (if it is included in the original route of the Node B of the path), but its DHO functionality is not applied to the concerned data flow. If the data flow had to make a detour to reach the DHO node, the DHO node will not remain in the path after its removal.

Please amend the paragraph beginning at page 38, line 15, as follows:

In several of the delay reduction methods the RNC ~~needs to calculate~~ calculates the potential path delay reduction (in terms of delay metrics) and/or cost increase (in terms of the generic cost metrics for the whole DCH) that would result from the removal of a certain DHO node from the path.

Please amend the paragraph beginning at page 52, line 22, as follows:

A DHO Node Selection Algorithm for Cascaded Base Stations

~~It should be noted that the following description of the DHO Node Selection Algorithm for Cascaded Base Stations is not within the scope of the claims but is disclosed to give a better understanding of the invention.~~

Please amend the paragraph beginning at page 54, line 7, as follows:

This algorithm ~~requires~~ assumes that all the Node Bs in the sequence of cascaded Node Bs (or at least the radio active Node Bs in the sequence) are DHO enabled. If not all the Node Bs in the sequence of cascaded Node Bs are DHO enabled, the algorithm may be extended with the following rule. If one of

the radio active Node Bs, except the one furthest away from the RNC, cannot act as a DHO node because it is not DHO enabled, it is replaced (as a DHO node) by the next available DHO enabled node in the direction of the RNC. This next available DHO enabled node may be another radio active Node B, a non-radio active Node B, the RNC or even a future type of RNL node (e.g. a specialised DHO node). However, if the DHO node selection algorithm is designed to select DHO nodes only from the radio active Node Bs (and the RNC) then a non-radio active DHO node or a future type of RNL node cannot replace a non-DHO enabled radio active Node B as a DHO node.

Please amend the paragraph beginning at page 56, line 22, as follows:

When performing the calculations of accumulated generic cost metrics, as described above in conjunction with the DHO node selection algorithm, for DHO node selection or for calculation of potential cost increase (as a result of a potential DHO node removal), it ~~must~~ should be taken into account a fundamental difference between off-tree and on-tree DHO enabled nodes. For an on-tree DHO enabled node there will always be at least one data flow to and from the node's uplink interface, whether the node is selected as a DHO node or not. However, this is not the case for an off-tree DHO enabled node. If the off-tree DHO enabled node is not selected as a DHO node, there will be no data flow to or from the node in any direction. Thus, the data flows between an off-tree DHO node's uplink interface and the original route tree must be considered in the calculations, since it represents a cost increase resulting

from the selection of the off-tree node as a DHO node. Hence, an off-tree DHO enabled node is not likely to be selected, unless the accumulated generic cost metric from the corresponding branching node to the off-tree DHO enabled node is very low, like e.g. if the off-tree DHO enabled node is a Node B that is co-located with the concerned branching node.

Please amend the paragraph beginning at page 58, line 13, as follows:

The Node Bs with DHO functionality preferably use an adaptive timing scheme to optimise the trade-off between delay and frame loss in the uplink combining.~~The timing scheme is however not within the scope of the present invention.~~

Please amend the paragraphs beginning at page 59, line 1, as follows:

To establish a hierarchical macro diversity structure the selected DHO nodes ~~need to~~ should be instructed so that they know where to send split downlink flows and what uplink flows to combine. These DHO node instructions are based on the DHO node tree that is the outcome of the DHO node selection process. Every time the DHO node tree changes (due to addition or removal of macro diversity legs) all the affected nodes (both DHO nodes and non-DHO Node Bs) need new instructions. Instructions are also needed when DCHs are added or removed from all macro diversity legs. DHO nodes may also in accordance with an embodiment of the present invention need QoS instructions when DCHs are modified in a way that the QoS of their transport

bearers have to be changed. The affected nodes may range from a single to all Node Bs in the DHO node tree. No signaling is required when only the S-RNC is affected.

In order to direct the DCH data flows in accordance with the DHO node tree the RNC ~~must~~ should provide the involved Node Bs with the IP addresses and UDP ports (in an IP UTRAN) or ATM addresses and SUGR parameters (in an ATM UTRAN) that they need to establish the inter-Node B transport bearers. If a transport network control plane protocol is used, the Node Bs handle this transport network control plane signaling between themselves and intermediate routers or AAL2 switches for inter-Node B transport bearers. However, there is no inter-Node B RNL signaling.

Please amend the paragraph beginning at page 65, line 14, as follows:

As stated above the RNC ~~cannot~~ may not explicitly instruct a DHO node of what destination IP address and UDP port to use for a transport bearer towards a hierarchically lower node. Actually, the RNC ~~cannot~~ may not even explicitly inform a Node B that it has been selected as a DHO node and when the DHO functionality should be initiated or terminated. Instead a DHO enabled Node B ~~has to~~ can rely on implicit information in the data flows to trigger initiation and termination of the DHO functionality and to find out where to direct split data flows.

Please amend the paragraph beginning at page 66, line 8, as follows:

The Node B ~~does~~ may not receive any explicit QoS instructions for the new transport bearer towards the hierarchically lower node, so if needed, the Node B ~~has to~~ can derive the required QoS information from the DCH characteristics (which is already known in the Node B) or copy the QoS class (e.g. DiffServe code points) used for the transport bearer of the same DCH towards the next hierarchically higher node.

Please amend the paragraph beginning at page 67, line 21, as follows:

Thus, the RNC ~~in accordance with the present invention comprises~~ can include means for obtaining topology information comprising a hop-by-hop route from the RNC to each of its connected Node Bs and at least one metric for each hop in the route, and means for using an algorithm for selecting a DHO node.